RESEARCH HIGHLIGHTS

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TECHNOLOGY ROADMAP FOR INTELLIGENT BUILDINGS

Introduction

This Technology Roadmap explores and explains the current status and imminent opportunities offered by the accelerating evolution and use of intelligent building technologies. The focus is on commercial, institutional and high-rise residential buildings, both new projects and retrofits, in a five-year time horizon. This study was supported by Industry Canada, National Research Council, Public Works and Government Services Canada, Natural Resources Canada and Canada Mortgage and Housing Corporation.

Intelligent Buildings and their Technologies

Intelligent buildings apply technologies to improve the building environment and functionality for occupants/tenants while controlling costs. Improving end user security, comfort and accessibility all help user productivity and comfort levels. The owner/operator wants to provide this functionality while reducing individual costs. Intelligent Building Technologies make this possible. An effective energy management system, for example, provides lowest cost energy, avoids waste of energy by managing occupied space, and makes efficient use of staff through centralized control and integrating information from different sources.

An efficient integrated system enables a modern, comprehensive access and security system to operate effectively and exchange information with other building systems. Fully integrated functionality will include the ability to open doors, notify responsible staff of unwanted intrusions and ensure that lighting, fire and other building management systems are informed of staff that arrive or depart the building. This information can then be used to manage the local environment and the resulting energy usage. Life safety systems, notably fire systems, are heavily regulated by stringent code requirements. These requirements do not, however, prevent the information from a fire system being provided to other systems.

This opportunity can be exploited to open doors and illuminate a building when fire alarms are received. Transducers (detectors) can measure many building parameters, e.g., vibration, strain and moisture, to continually monitor the building's infrastructure condition.

To integrate these systems and exchange information effectively, a ubiquitous and reliable communications infrastructure is needed. These systems are typically managed by personal computers (PCs) using data processing communication techniques. A heavy communications emphasis is essential, and both wired and wireless communication technologies are available. The key communications issues are redundancy, resilience, security and the assurance for all users that "their data" is secure. Integration considerations may be addressed through standards and conventions, or manufacturers' protocols. Since proprietary solutions permeate the industry, total interworking is currently unattainable. The future will require full interoperability, with information exchanged among all systems. There is an opportunity for technologies that translate protocols and conventions so that systems are fully interoperable.

Optimized communications involve designs that use structured wiring standards with dedicated communications rooms, with equipment sharing a common space and a common backbone. This infrastructure will adhere to the Open System Inter-connection model of seven communications layers. Distributed equipment must be capable of operating when the communications infrastructure fails. Distributed control and distributed

diagnostics will ensure that the functionality of all building systems is respected, and any single fault cannot invoke a generalized building failure. Among the candidates for wide adoption as standards, both BACnet and LonWorks currently exist and have widespread followings. However, even these available systems do not generally fulfill the requirements for interoperability.

The Benefits

Many of the concepts which are central to intelligent buildings are already commonplace, e.g., the ability to access a building independently and securely outside of normal working hours. The major benefits of intelligent buildings are as follows:

- standardized building systems wiring enables simple upgrade modifications of control systems;
- a higher value building and leasing potential can be reached via increased individual environmental control;
- consumption costs are managed through zone control on a time of day schedule;
- Occupants/tenants control building systems after-hours via computer or telephone interface;
- Occupant/tenant after-hours system use is tracked for charge back purposes;
- the service/replacement history of individual relay and zone use is tracked; and
- a single "human resources" (hire/fire) interface modifies telephone, security, parking, LAN, wireless devices and building directory, etc.

These useful benefits can be cost effective. Cost savings benefit primarily the developer/owner/operator, while functional enhancements are mainly enjoyed by the occupants/tenants. If improved comfort, security, flexibility and reliability can be achieved along with reduced costs and increased productivity, thus increasing return on investment, few would argue against the deployment of such technology.

The benefits from projects where these technologies have been exploited are often described. However, the Technology Roadmap has found a scarcity of reference projects that are fully instrumented and documented. Reference projects must apply equivalent technologies to new or retrofit projects and draw careful conclusions regarding the proposed investment and the projected return. These projects must identify and quantify the risks and the rewards. These evaluations must allow for appropriate substitution.

Many intelligent buildings projects have been showcase projects, demonstrating specific attractive examples but not seriously quantifying the costs and values. Without careful quantification, the economic case for intelligent buildings cannot be made, since the initial costs are often high. For example, energy cost is a key factor and rising energy costs can change the conclusion. The Technology Roadmap has studied published material and created a reference library on the CABA Web site http://www.caba.org/trm.

The Challenges

The financial impact is always significant, including capital costs, expenses and revenues. Financial implications must be correctly assessed, including the time value of money and tax effects. Low initial costs are attractive to developers, while the owners/operators and occupants/tenants are more interested in ongoing operational costs. Intelligent buildings offer major opportunities to increase revenue and offer more value, hence to sell/rent for higher prices and/or more rapidly. Financial decisions that compare alternative plans considering only initial cost will usually be wrong. If the revenue stream is the same, then ongoing expenses should be judged via the metric present worth of annual charges (PWAC). If the alternatives generate different revenue, (usually the case with intelligent buildings), the correct metric is net present value (NPV). The initial cost should only be the deciding factor when the metrics of alternative plans (PWAC where revenue is uniform and NPV where revenue varies) have similar results.

The improved value of intelligent buildings should encourage developers/owners/operators and the entire supplier community to take advantage of these opportunities. Intelligent building projects will affect the construction processes. The successful outcome requires an integrated design, with practical solutions with regards to divisional specifications, contracts and the interaction of the design, management and construction staff on the project. Changes in approach will be needed throughout the supplier community.

Intelligent buildings must react to component and system failures more reliably than "conventional" systems, using system design to ensure problem isolation and resolution that improves on "conventional" performance. Education,

experience and changed practices will be required throughout the supplier community, including engineers, designers, architects, contractors, manufacturers, and those who manage and maintain the systems. Provision and use of common space, common infrastructure and shared resources are central to the economic effectiveness and advantage of intelligent buildings. A building and its infrastructure typically have a lifespan of 25 years or more between major retrofits. Intelligent buildings offer the ability to upgrade functional capability more often and much more economically, through upgrading components and equipment items without changing physical components, e.g., cabling.

Authorities having jurisdiction must ensure that codes, practices and conventions support and encourage the deployment of intelligent buildings, to gain the functional and financial value. The advantages of intelligent buildings highlight the need for rules and regulations to encourage the use of intelligent building technologies while ensuring that public safety and public service are well addressed.

Future Directions

The most successful intelligent buildings indicate that the greatest advantages come from integrating communications and ensuring that the traditional systems have the ability to intercommunicate and interoperate. A single operator interface must recognize status and control information of all available systems. The primary benefit comes from the shared space, infrastructure and operating staff. Current trends to work from home encourage remote interaction with building communications and services.

These trends are being influenced by technologies and the current market situation. Construction methods and technologies are breaking down some conventional barriers. Increasing concern with environmental impacts and with security needs are market forces that influence intelligent buildings functionality.

Intelligent buildings depend on the increasing reliability of secure and resilient communication infrastructures. Mobile telephones are well established, encouraging mobile communications in many other forms. This technology has value for in-building applications. For the occupants/tenants and the operators, these technologies yield substantial efficiencies. These evolving concepts will lead to intelligent building technologies that are not yet on the drawing board.

Conclusions and Recommendations

The major conclusions and actionable recommendations to promote intelligent buildings are:

- Intelligent building technologies are generally available but are not yet widely adopted;
- there is reluctance by much of the development and construction industry to embrace them;
- many changes and initiatives must occur for these technologies to become widespread; and
- there is a need for promotion and education at all levels and in all segments of the industry.

This Technology Roadmap recommends many actions that require co-operation, as is typical of progress in technology applications in today's world. The adoption of intelligent buildings offers major advantages, faces significant challenges, and is moving forward because of the vision and dedication of individuals and organizations.

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